Estimation of the contribution of the effect of collisions of objects larger than 1 cm in size

A.I.Nazarenko[1], Scientific and Technological Center "Cosmonit", Roscosmos, *anazarenko32@mail.ru*

Problem

The results of studying the effect of catalogued objects' collisions on the near-Earth space (NES) contamination have been considered at last IADC sessions [1]. Collisions of smaller objects have not been considered. The author believes that this is explained by two reasons:

1. Existing fragmentation models are poorly suited to accounting for diverse collision conditions.
2. A great number (millions) of non-catalogued objects cause high methodological and computation difficulties in modeling the collisions.

That's why these problems have been primarily considered in our work.

Fragmentation model

The fragmentation model is based on the known relationship [2, 3] for a number of formed particles having mass larger than m

$$N(>m) = A \cdot (m/M)^B. \quad (1)$$

At catastrophic collision $M = m_1 + m_2$ is the mass of colliding objects.

Some inaccuracies of known models were revealed in the analysis process. Namely:

- The error was found in the known formula for determining the mass of a maximum fragment $m_{\max} = M \cdot (1+B)/(-B)$. The correct formula is as follows:

$$m_{\max} = M \cdot (B+1) \Big/ \left[1 + B \cdot (m_{\min}/m_{\max})^{B+1}\right]. \quad (2)$$

- There is no substantiation of choice of fragments' minimum size.

- The formula for determining the energy released at collision is a particular case of a more general formula applicable for various collision conditions

$$u = U/M = \frac{1}{2} \cdot k_1 \cdot k_2 \cdot V_{imp}^2 \quad (3)$$

Here $k_1 = m_1/M$, $k_2 = m_2/M$.

In calculating the energy required for forming the fragment having the destruction surface area S_j we use the assumption that this energy is proportional to the destruction surface area, i.e.

$$u_j = S_j \cdot g \ . \quad (4)$$

Here g is some constant, which depends on fragment's material.

The algorithm for calculating, on a model, the collision consequences, that takes into account the released energy estimate (u), consists of the following operations:

1. The maximum mass and size of fragments are calculated.
2. The cycle over possible (discrete) values of fragments' size ($d_{j=1}$), beginning with the largest fragment, is organized;
3. For each fragment size in the range of (d_j, d_{j+1}) one calculates the values of the mean destruction surface area S_j, the volume and mass value m_j. Here, the assumptions on

[1] This work was supported by Roscosmos